

RESEARCH ARTICLE

Voices of rural people: Community-level assessment of effects and resilience to natural disasters in Odisha, India

Sangram Kishor Patel*, Bincy Mathew, Ankit Nanda, Biswajit Mohanty, Niranjana Saggurti

Population Council, Zone 5A, IHC, Lodi Road, New Delhi, India

ARTICLE INFO

Received: July 2, 2019
Accepted: January 17, 2020
Published: February 6, 2020

***CORRESPONDING AUTHOR**

Sangram Kishor Patel,
Senior Program Officer,
Population Council, Zone
5A, IHC, Lodi Road,
New Delhi - 110 003, India.
sangramkishor@gmail.com,
skpatel@popcouncil.org

CITATION

Patel SK, Mathew B, Nanda A, Mohanty B, Saggurti N. (2020). Voices of rural people: Community-level assessment of effects and resilience to natural disasters in Odisha, India. *International Journal of Population Studies*, 6(1):3-15. doi: 10.18063/ijps.v6i1.1042

Copyright: © 2020 Patel, et al.

This is an Open-Access article distributed under the terms of the Creative Commons Attribution-Non Commercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), permitting all noncommercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract: Globally, natural disasters have caused a large scale of damage and destruction every year, affecting millions of people, the economy, and development – and developing countries are the most severely affected. Odisha is one of India’s most disaster-prone states. This study explores the effects of, and resilience to, cyclones, floods, droughts, and heatwaves in Odisha, and identifies government strategies that help mitigate these natural disasters. We mainly used primary data collected through a qualitative study undertaken from April 2017 to June 2017 in three districts of Odisha. We conducted in-depth interviews and focus group discussions with community members and key stakeholders at different levels. In addition, our study analyzed secondary data on natural disasters using DesInventar, a disaster information management system data source. The findings show that floods, cyclones, and drought in recent years, along with heatwaves and lightning, have severely affected the people of Odisha. The impacts of these natural disasters are calamitous – particularly on livelihoods, food security, health, water, and sanitation. These natural disasters, which have affected agriculture, fisheries, prawn cultivation, roadside vendors, and daily wage laborers, have both short- and long-term effects on the livelihoods of people in Odisha, leaving them with scarce employment opportunities. The vulnerable and marginalized sections of the population have been the most severely affected, and common coping mechanisms have included selling off livestock, borrowing food, taking loans and mortgages, and migration. The government’s measures/programs, such as an Early Warning System, Public Distribution System, Multipurpose Cyclone Rehabilitation Centers, Seasonal Residential Care Centers, and Indira Awas Yojana, play a major role in mitigating the effect of disasters among rural communities. Our study indicates that natural disasters have impacted the population of the state socioeconomically, physically, and psychologically. The effect on livelihoods, directly and indirectly, exacerbates income, food security, and health. There is an urgent need to focus on reducing people’s underlying vulnerabilities by taking proactive measures, engaging the community in decision-making, and generating alternative and sustainable livelihoods.

Keywords: Climate change; Effects; India; Natural disasters; Odisha; Resilience

This article belongs to the *Special Issue: Environment and Population Dynamics in South Asia*

1. Background

Natural disasters count among the prominent events that devastate populations, economies and impede development both in developed and developing countries. On a global level, over 98 million people were affected and US\$66.5 billion in economic damages were incurred in 2015 alone due to natural disasters (UNISDR, 2016). India, one of the most disaster-prone countries, supports around one-sixth of the world population on 2.4% of the world’s landmass. The country has experienced multiple disasters and has 40 million hectares of land that is susceptible to floods, a long coastline

prone to cyclones, and 68% of its agricultural land vulnerable to drought. In addition, the annual mean temperature is on the rise (an increase of 0.86°C between 1901 and 2014) (GOI, 2004; Radhakrishnan *et al.*, 2017). About 330 million people in India were affected by droughts in 2015 and 2016, the greatest number affected by a natural disaster (Guha-Sapir *et al.*, 2016). In India, heatwaves have proved deadly, with 3028 lives claimed in 1998, over 2000 lives claimed in 2002 (NDMA, 2017), and 2248 deaths in 2016 (UNISDR, 2016). Nearly 6500 people lost their lives in floods in India in 2013 (UNISDR and CRED, 2015). In 2013, cyclone Phailin displaced approximately 1 million people (IDMC, 2014). These disasters wreck every aspect of people's lives, destroying their livelihoods, harming their health, and causing damage to the ecosystem and infrastructure. Natural disasters not only affect physical health but also cause many psychosocial outcomes and considerable stress among the population. It has been evident that heatwaves have become more intense and frequent in recent decades and claim the lives of people each year (NDMA, 2017; UNISDR, 2016).

Odisha features among the states in India most vulnerable to climate change and the occurrence of natural disasters, including floods, cyclones, drought, and heatwaves (Ray Bennett, 2009; GOI, 2012; GOO, 2016; Patel, 2016). The geographic location and climatic conditions of Odisha have led to multiple disasters over the years (GOO, 2002). Floods are the most frequent natural disasters in Odisha due to its long coastline and multiple rivers. With the state receiving 80% of its rainfall in 3 monsoon months, any variation in rainfall can lead to droughts and affect the majority of the population that is dependent on agriculture (GOO, 2016). Cyclones have claimed lives and destroyed infrastructure in Odisha and have proven destructive especially for the people living along its coastline. Increasing levels of pollution, deforestation, and industrialization have made the heatwaves common in parts of the state, with the deadly heat wave of 1998 claiming over 1000 lives in the state (GOO, 2016). Odisha has been affected by disasters for 90 of the past 100 years (Sharma *et al.*, 2016). The socioeconomic profile of the state, its dependence on agriculture and other nature-based livelihoods, and a population more than two-thirds under the poverty line make it ripe for natural disasters (Mishra, 2015). This combination of extremely disaster-prone geographical location, low socioeconomic indicators, and changing weather patterns resulting from climate change make it the disaster capital of India (Sharma *et al.*, 2016).

Although many studies in Odisha have focused on mapping and vulnerability assessment for disasters, few studies have provided an in-depth understanding of the effect of natural disasters on rural communities. To add to the limited literature on the effect of natural disasters and resilience at the community level in Odisha, our study examines the cumulative effects of natural disasters in Odisha from 1970 to 2014. In addition, it explores people's perceptions of the effects of, and resilience to, cyclones, floods, droughts, and heatwaves identifies government strategies that are helping communities mitigate these natural disasters; and provides recommendations to strengthen responses to natural disasters in the state. We believe that this comprehensive study will be useful in strengthening the state's policies and programs, as well as helping the population.

2. Data and Methods

This study used data from both a secondary source (quantitative data) and primary research (qualitative data) to answer the key research questions:

- What are the mechanisms through which disasters affect the livelihood, food security, health, and other socioeconomic conditions of people?
- What are the community responses, and the approaches of the different departments and public policy to prevent or address the natural disaster impacts?

2.1. DesInventar: A Disaster Information Management System

This study analyzed the secondary data on natural disasters and their impact on socioeconomic dimensions and infrastructures in Odisha using DesInventar, a disaster information management system data source. DesInventar is an open database of natural disaster events reported in the media between 1970 and 2014 in 89 countries (UNDRR, 2015). DesInventar is a conceptual and methodological tool for the generation of national disaster inventories and the construction of databases of damages, losses, and, in general, the effects of disasters. These methodologies and software packages have been developed by the DesInventar project team with support from the following institutions and partners: UNDRR (United Nations Office for Disaster Risk Reduction), UNDP (United Nations Development Programme), LA RED (The Network of Social Studies on Disaster Prevention in Latin America), OSSO (Corporacion Observatorio Sismológico del Sur Occidente), RobotSearch Software, and Apache Software Foundation.

2.2. Primary Qualitative Study

2.2.1. Study design and settings

This study is mainly based on the primary data collected through a qualitative study. The study was conducted in three districts (i.e., Jagatsinghpur, Nuapada, and Sundargarh) of Odisha, India from April 2017 to June 2017. The primary data on effects and resilience to floods, cyclones, droughts, and heatwaves were collected from the community members at the panchayat level (e.g., panchayat consists of a village or a group of villages divided into smaller units called “wards”), and different stakeholders at the panchayat, block, district, and State Level in Odisha. For the study, one district highly vulnerable to cyclones/floods (e.g., Jagatsinghpur), droughts (e.g., Nuapada), and heatwaves (e.g., Sundargarh) was randomly chosen from the list of respective disaster-vulnerable districts of the state. In the second step, one highly vulnerable block was chosen purposively in each selected district. In the third step, two rural panchayats were randomly chosen from the selected block in the selected district.

2.2.2. Study participants

The qualitative data were collected using in-depth interviews (IDIs) and focus group discussion (FGD) guidelines. Qualitative data were collected among community members (i.e., farmers, women with children, young women (18-21 years), daily wage laborers, older persons, and disabled individuals) using both IDI and FGD guidelines, and among stakeholders (i.e., panchayat level, district emergency office, district medical office, and district agriculture department) using IDI guidelines. In addition, government officials were interviewed using IDI guidelines at the state level (i.e., Odisha State Disaster Management Authority, State Meteorological Department; State Agriculture Department; and State Directorate of Health). A total of 62 IDIs with different stakeholders and 6 FGDs with adult populations were conducted in the state. A detailed outline of the qualitative interviews is given in Table 1. Issues explored during the data collection were: (i) Effect of natural disasters on: Livelihood, food security, water and sanitation, health, and other socio-economic conditions; (ii) disaster resilience (coping and adaptation strategies at the community level); and (iii) government measures on disaster management.

2.2.3. Ethical statement

Overall study design, study tools, and consent processes were reviewed and approved by the Institutional Review Board (IRB) of the Population Council in New York. Written consents were obtained from all participants before participation in the IDIs and FGDs, and steps were taken to ensure their confidentiality. For this study, male or female adults aged 18 years or older who had experience with or exposure to natural disasters or extreme weather events in their life were recruited as participants, and the information was collected accordingly. No names and addresses were recorded. Participants were not provided any compensation for their time in the study.

2.2.4. Data collection and analyses

Qualitative data for the study were collected by trained Population Council researchers. Interviews were audio-recorded and conducted in the local language (Oriya), and then directly transcribed by the researcher into English. Qualitative data analysis was done using ATLAS.ti (6.1 version) software and based on the themes; codes were prepared.

Table 1. Description of qualitative interviews conducted by districts, Odisha, 2017.

Qualitative interviews	Districts		
	Sundargarh	Nuapada	Jagatsinghpur
FGDs (Total=6) – with adult community members (18+years)	2	2	2
1 with adult females in each district			
1 with adult males in each district			
IDIs (Total=62)			
Community members at panchayat level	13	13	14
Stakeholders at panchayat level	2	2	2
Stakeholders at block/district level	4	4	4
Stakeholders at State Level (Total=4)	-	-	-
Total IDIs at the district level	19	19	20

IDIs: In-depth interviews; FGD: Focus group discussion.

3. Results

3.1. Cumulative Effects of Disasters in Odisha

Out of different natural disasters that have occurred in Odisha from 1970 to 2014 (Tables 2 and 3) (data showed here in percentages), floods have affected people the most, both directly (63%) and indirectly (72%), followed by cyclones (36% vs. 21%). In addition, flooding was the deadliest disaster in terms of damaged houses (50%), damaged roads (in meters) (63%), lost cattle (76%), missing people (25%), and economic losses (92%, approximately 22,022.2 million INR). The results also show that the cumulative effect of cyclones was highest in terms of deaths (37%), houses destroyed (46%), people evacuated (57%), and damaged educational centers (80%), and hospitals (49%) as compared to the total natural disasters that occurred between 1970 and 2014. Drought has been the leading cause of crop loss (50%), damaging 12,046,254 ha of crops. Over the years, heatwaves have also been affecting people, causing health concerns, and deaths.

3.2. Effect of Disasters on Livelihood, Food Security, Health, and Other Socioeconomic Conditions

According to the participants in our study, floods, cyclones, droughts, heatwaves, thunderstorms, and lightning are the most prevalent disasters in the state. The findings show that natural disasters had immense health and socio-economic consequences for rural people in Odisha. In Jagatsinghpur, participants pointed out that essential services such as electricity and water supply were suspended during floods and cyclones, and transportation and communication were disrupted leading to a delay in the distribution of relief. The problems persisted for 2-3 months, and the period of recovery lasted up to 4 months. The study also traced changes in the impact of cyclones over the past two decades. According to the participants, while the super cyclone in 1999 led to deaths and destroyed houses with thatched roofs, people were much more prepared during subsequent cyclones, although it was still devastating for them.

“Our house was completely washed away, and there were no remains of it. Our paddy crop was also destroyed completely. We had nothing except clothes. We stayed under a polythene hut for more than 6 months. In 2013, the main house did not collapse but the thatched roof was destroyed, the kitchen and the cattle shed collapsed, there was no food to eat for 2-3 days after cyclone Phailin. The crop was badly affected. The fish pond was submerged and all the fishes were lost. The entire lot of paddy seeds were destroyed. The tube well also broke as tree branches fell on it. So in 2013 cyclone, the accumulated loss was over 2 lakhs INR.” (Unmarried female, 20 years, IDI)

Participants in rural communities in Nuapada, Jagatsinghpur, and Sundargarh pointed out that natural disasters impacted children’s education. When cyclones hit, schools remained shut because they were used as shelters for a long

Table 2. Cumulative impacts of natural disasters on population, Odisha, 1970-2014.

Natural disasters	Deaths	Injured	Missing	Directly affected	Indirectly affected	Evacuated
Cyclone	21,112	943	143	941,902	27,905,612	2,218,588
Flood	3545	138	176	1,636,685	93,352,240	1,555,800
Drought	2217	223	NA	20	3,486,756	NA
Heatwaves	1033	285	NA	0	723	NA
Total*	57,306	86,154	716	2,600,441	130,524,600	3,900,450

Source: DesInventar; NA: Not applicable; *total includes impacts from cyclones, floods, droughts, heatwaves and other natural disasters.

Table 3. Cumulative impacts of natural disasters on socio-economic factors and infrastructure, Odisha, 1970-2014.

Natural disasters	Houses destroyed	Houses damaged	Education centers	Hospitals	Crops damaged (in hectares)	Lost cattle	Road damaged (in meters)	Losses in INR
Cyclone	885,218	1,919,219	8,128	191	4,050,726	946,327	27,366	13,973,002,737
Flood	391,124	1,965,313	1683	178	6,742,742	3,019,943	47,031,973	220,220,434,423
Drought	NA	NA	NA	NA	12,046,254	NA	NA	288,650,000
Heatwaves	NA	NA	NA	NA	NA	NA	NA	11,800,000
Total*	1,943,679	4,017,795	10,202	389	23,773,643	3,993,510	74,801	239,470,830,605

Source: DesInventar; NA: Not applicable; * total includes impacts from cyclones, floods, droughts, heatwaves, and other natural disasters.

duration. During drought situations, children of migrants often dropped out of school. Being in school beyond 9 am became difficult during heatwaves as the school building was made of concrete and there were no fans.

It was observed that these disasters affected agriculture, although with varying impacts. According to the majority of participants in the study sites, the changing climate, irregular rainfall, and recurrent disasters reduced crop productivity. Farmers had to contend with constant crop loss due to recurrent floods. Most participants in Jagatsinghpur said that floods and cyclones led to submergence of agricultural fields and saline water inundation, rendering agricultural fields uncultivable in subsequent years. When broken embankments were not repaired in time after the floods, the possibility of cultivation was delayed further. According to participants in Jagatsinghpur, the livelihoods of people engaged in fishing and prawn cultivation was affected due to the damage caused by cyclones to boats, fishing nets, fishponds, and prawn hatcheries that led to financial losses. The cultivation of tiger prawns reportedly stopped after the super cyclone in 1999.

“Here, the cultivation and the plantation are not possible due to saline water. Over the years, the production has gone down in our area.” (Housewife, 35 years, IDI)

Participants in Nuapada noted that groundwater depletion and water scarcity were characteristics of the present drought situation. Along with this, their major dependence on scarce rainfall and lack of adequate irrigation facilities led to crop loss. Farmers were not able to secure loans from formal sources for agriculture purposes if they failed to repay earlier loans. Farming had increasingly become an unviable occupation in recent years, rendering people engaged in the sector highly vulnerable. Droughts affected the prospects of sharecroppers and small and marginal farmers. Agricultural laborers were also affected due to the lack of farm work.

“Farmers are largely affected by drought. As there is no agriculture and production, we don’t have any earning. Because of this, we are not able to send our children to school and always encounter problems in feeding our family and providing clothes to family members. We are not even able to provide treatment when our children have any health problems.... There is no money with us for our sorrow and happy time, and for treatment.... Usually, food and work are available when paddy is harvested. If there is no rain, then there is no paddy and no work is available in our area. Due to this, older people like us face more problems.” (FGD participant, Nuapada)

Most participants in Sundargarh said they had experienced temperature increases up to 50°C during March–June in the last decade. Participants observed that heatwaves had become more intense in Sundargarh and affected the livelihoods of roadside vendors, small businessmen, rickshaw pullers, and daily wage laborers. Heatwaves affected cattle rearing due to a lack of vegetation during the dry season. With the rising temperature, the cattle died roaming in the heat due to lack of water; hence, people were no longer interested in keeping them. The rising temperatures made it difficult for people to work in the scorching heat, thus hampering their limited income-earning opportunities. Heatwaves also had an impact on people’s routines, because they were unable to go out in the extreme heat and eat or sleep properly.

“It is very difficult to go outside after 10 am and the heatwave persists up to 4 pm in the daytime. After 1 pm the hot wind blows, and it is difficult to stay home in the afternoon. I usually go to the shade of a mango tree near my home. For me, it is difficult to move because my left leg and left hand are affected by polio. So, I move by an old tricycle. Riding tricycles on a bad road in this scorching heatwave is really challenging for me. I have to hold the tricycle only in one hand, which requires a fair amount of energy, and due to this I feel tired quickly. Every day, I have to go to the pond which is around 500 m away from my home to perform daily activities like toilet and bath.” (Person with disability, 18 years, IDI)

Participants from the three study sites experienced the effects of natural disasters on their food security. Participants in Nuapada described the changes in food security concerns that have occurred over the decades. While thousands died of starvation as a result of the droughts in the 1980s, the government response to drought at present was said to be much better. Participants pointed out that when droughts occurred for consecutive years, the challenge to meet food requirements became arduous, as food grains were not stored beyond a year. Income loss in Sundargarh posed similar challenges for food security. In Jagatsinghpur, participants noted that the food stock got depleted within 10 days after floods and cyclones. Stored food grains were washed away, and shops did not open for weeks. Another challenge that emerged was that standing crops and farm vegetables were damaged during floods, affecting the availability of food. Some participants recounted the debts that were incurred in trying to meet food requirements in a large family.

As per the participants, natural disasters affected the quality and accessibility of drinking water, sanitation, and irrigation in the study sites. In Jagatsinghpur, the invasion of saline water in the land area affected drinking, cultivation, and daily life. The scarcity of water during droughts and heatwaves affected drinking, bathing, sanitation, daily household uses, irrigation, and cultivation, particularly for the disabled and older population. In some places, it was also reported that women had to travel far to fetch water, and in a few places, the waiting time at tube wells had increased by up to half an hour.

“Water scarcity leads to low productivity in the land, and livestock do not get sufficient water. We are always facing problems for bathing, washing, and drinking water.” (Housewife, 27 years, IDI)

Other water sources, such as ponds, had dried up, and the water level in the river had also reduced. Participants in Sundargarh stated that the lack of water disrupted the supply of electricity, which resulted in the irregular supply of drinking water. Heatwaves and droughts have become more intense in recent years in Odisha as a result of less rainfall and extreme temperatures in the area.

Communities reported multiple health problems resulting from natural disasters. Participants in Sundargarh particularly noted an increase in incidence of sunstroke and deaths related to heatwaves. Participants listed a number of signs and symptoms of health issues related to heatwaves such as dehydration, heat cramps, heat exhaustion, sweating, swelling, fainting, dizziness, headache, body ache, vomiting, fever, and diarrhea. Heatwaves also created health problems for people who worked outdoors to earn a living. School and college-going students experienced head reeling (vertigo) and weakness, while pregnant women reported feeling uneasiness during heatwaves. Participants in Nuapada described suffering from a number of ailments, such as malaria, anemia, malnutrition, diarrhea, and weakness during drought periods. Participants reported that the health of migrants returning from destination states was affected. They also reported that malaria was highly prevalent in the area, and an average of 30 patients were admitted to the hospital every month.

According to participants in Jagatsinghpur, floods, and cyclones caused diarrhea, malaria, jaundice, pneumonia, vomiting, fever, cold and skin infection, and even led to deaths following an outbreak of diseases. With the inundation of water, often contaminated with the presence of dead bodies and open defecation, people contracted diseases, and snake bites. Other impacts of disasters included mental health problems. Some people developed psychological problems because they did not have jobs and struggled to make ends meet as a result of droughts and heatwaves. Cases of post-traumatic stress disorder (PTSD) and trauma have also been reported, particularly after the 1999 super cyclone in Jagatsinghpur.

“Many severe mental health problem cases were observed at that time. Many people were in mental trauma or post-traumatic disorders after the 1999 cyclone. Some people did not even recognize their family members. We had seen people in our area that could not recognize their family members, and when they saw us they called us by their daughter’s name or some even said you are my daughter. The situation was so sad, you can’t imagine. It happened due to the shock of super cyclone.” (FGD participant, Jagatsinghpur)

Psychological trauma, stress, and depression have also been reported, linked with continuous losses in agricultural livelihoods due to natural disasters in the study sites in Odisha. People in Nuapada, Jagatsinghpur, and Sundargarh faced financial hardship in seeking treatment and traveling to reach government hospitals. Although they received free medicine from government hospitals for small ailments, in many cases, they said they had no option but to do medical tests and purchase other medicines from private pharmacies/shops. The burden of extreme events exacerbated their debt, and out-of-pocket health expenditures worsened their financial position. It was also seen that health facilities were not equipped, and hospital staff was inadequate during cyclones and floods as large numbers of people visited hospitals at that time.

3.3. Community Resilience and Government Measures to Mitigate Natural Disasters

3.3.1. Community coping and adaptation strategies

Qualitative results showed that many coping and adaptation mechanisms were taken by communities to protect or mitigate the natural disasters in the study areas (Figure 1). This figure described that natural disasters are reported to affect agriculture, food security, livelihood, health, drinking water and sanitation, and the infrastructure of the state. However, the governmental initiatives such as crop insurance, weather forecasting, compensation schemes, health camps, etc. together with individual/community strategies such as changing diet, storing food grains, crop diversification, etc. could build the resilience systems or cope with negative effects caused due to disasters.

Participants in Sundargarh undertook a variety of strategies to adapt to the rising temperature. They ate cucumber and watermelon and drank water, rice water, lemon water, soft drinks, curd water, *jaljiraa* (spice drink), *aam panna* (mango drink) and oral rehydration solution (ORS) supplied by *Anganwadis* (child-care centers). In rural Odisha, they poured water on their heads to keep themselves cool, stored water in earthen pots, and wrapped vegetables in wet clothes. People used fans/coolers, put up *khus-khus* (mats made of the woven roots of this perennial grass can keep out heat when bound with cords and hung in the doorway), and damped the door screens; and if there was no electricity in the afternoon, they damped their cotton mattresses. Some other coping mechanisms included covering asbestos roofs with straw, sprinkling it with water, and repairing tiles to keep the sun out. Those with cattle sprayed water on the roof of their cattle shed when the temperature rose. Participants mostly avoided venturing out during the scorching heat. If it was essential to

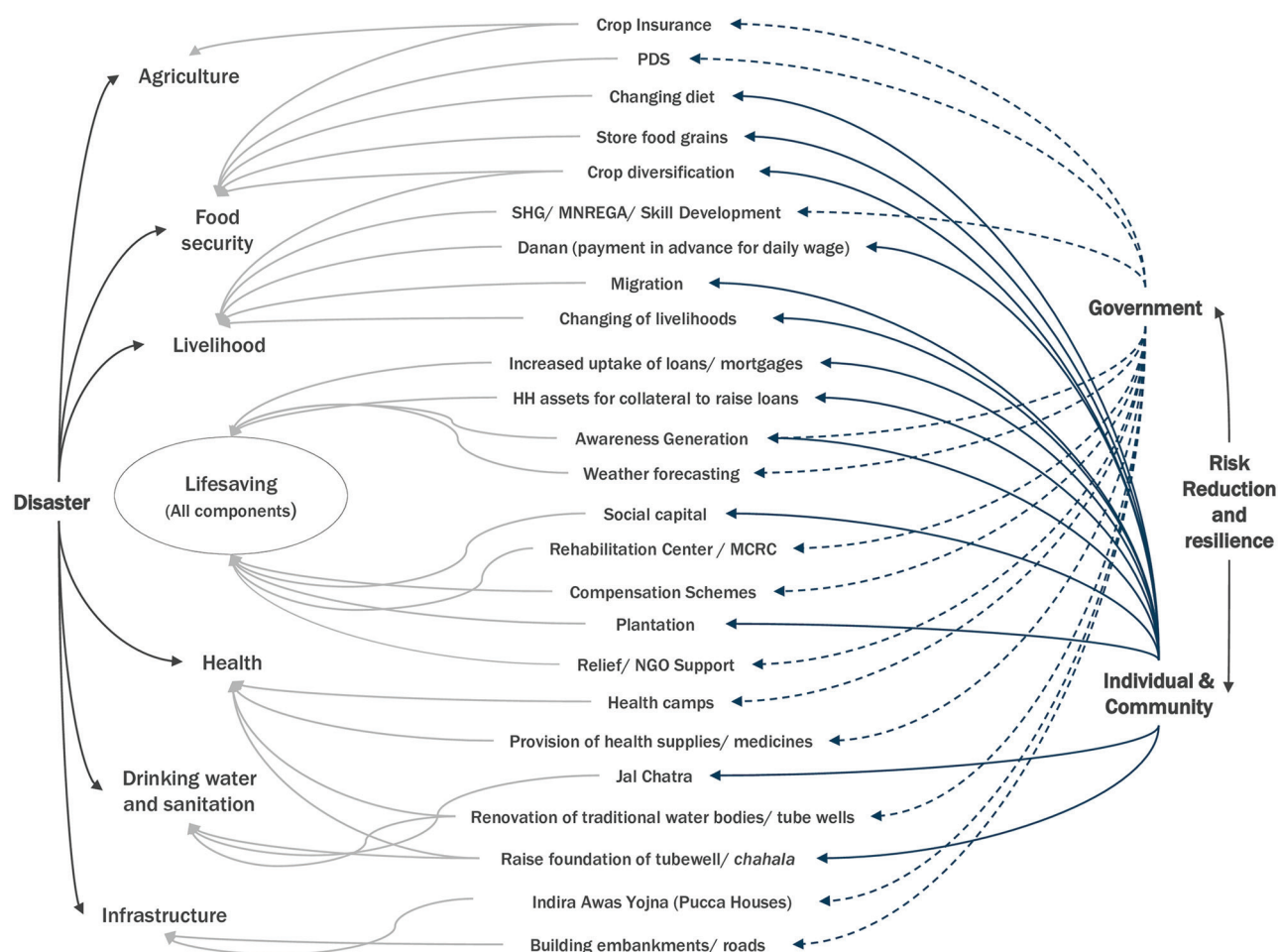


Figure 1. Pathways of effects, coping, and adaptation to natural disasters in rural communities in Odisha, India.

go out, participants carried water bottles, wore wet clothes, hats, and slippers, and used an umbrella. Often people were compelled to engage in labor work for their survival in the scorching heat as they had no other choice for earning, but they tried to avoid working during the peak heat hours.

“Before heat wave begins, I put straw on the asbestos and make the room cool and reshuffle the tiles. These activities are done in March. Water is sprayed on the roof of the cattle shed when the heatwave increases. I damp the door screen and by this way make the room cool and the children can sleep. Sometimes I use wet cotton mattress after 12 noon if there is failure of electricity to keep the room cool.” (Farmer, 51 years, IDI)

To cope with income shortages resulting from natural disasters (particularly in drought situations), people in Nuapada migrated for work to nearby towns and other states, changed their occupation, borrowed food from neighbors, and also depended on remittances. Participants in Nuapada stated that they took food on credit from shops and repaid their debts after they had earnings from migration. Sometimes people bought rice from shopkeepers by exchanging forest products or millet. Further, many rural participants stated that the Public Distribution System (PDS) was useful in an emergency, although insufficient. The results suggested that in many instances, people had to compromise on the food they ate due to the effect of disasters. Participants recalled that in the past, they stored surplus food grains to cope with droughts; however, they had to resort to other alternatives at present (e.g., migration). Migration (to work as bonded laborers [*Pathuria* or *Dadan* system] in neighboring states) had repercussions for individuals and their families, particularly in Nuapada. Participants further added that often migrants were unable to repay their debt.

“Earlier, people used to cultivate Mandia (finger millet), Suan (little millet), and Gurji (fox-tail millet) and stored these items in their home for future use, so when there was a drought they used the stored millets to manage their families. In case of emergency or shortage of food, people used to borrow or lend from the local money lender. Now

people in our area prefer to migrate for work outside in cases of drought or any family emergency. Earlier people feared going outside for work, but now people do not want to stay in trouble but prefer to migrate and earn to maintain their families.” (FGD participant, Nuapada)

Social capital was a key factor in the community response to cyclones and floods in Jagatsinghpur. Communities often took the first initiative to help, through family and community groups, with the government subsequently providing support. After the super cyclone in 1999, participants said that the community itself was the first to provide immediate help or shelter, and the government stepped in thereafter and offered support through rescue and relief activities. According to participants, there was a strong sense of community feeling during floods. People carried sticks and torchlights to rescue others onto river embankments and other areas. They also said that people ate rice left soggy after floods and green coconut to cope with food shortages in the immediate aftermath of cyclones or floods. Similar to Nuapada and Sundargarh, people in Jagatsinghpur skipped meals, and food was distributed equally among family members (particularly among children and elderly persons) during the aftermath of natural disasters.

After the 1999 super cyclone, community preparedness for cyclones was scaled up. Participants said that mechanisms to save human lives and cattle were given priority. People became proactive in taking preventive measures, such as storing flattened rice, jaggery, biscuits, potatoes and other vegetables, stoves and kerosene, and drinking water. When floodwater increased beyond a danger line, people moved to a higher place (e.g., stable *pucca* houses of neighbors, or public buildings such as multipurpose cyclone rehabilitation centers (MCRCs) and/or schools) with dry foods. Many villagers have built *pucca* houses with raised foundations. In their houses, they built a shelf (plank) for keeping important documents safe. The platforms of tube wells were raised, and toilets were built higher off the ground. Preservation of coastal mangroves to protect villages from the effects of cyclones was emphasized, and people grew plants locally that could shield homes from strong winds. Community members kept themselves updated and informed about impending cyclones and floods through television and newspapers.

“We have built a semi pucca (cement wall and thatched roof) house now. We have also planted acacia, eucalyptus, casuarina near the house to shield ourselves from the wind. We purchased TV and newspaper in our home to know disaster-related information. We also raised the foundation of our house for protection from water, and constructed high-rise tube well in the house for drinking water. In addition, we keep polythene and rope in our home, store kerosene, keep important documents in a box for safety, store food from August onward because of the prevalence of cyclone, particularly in October and November.” (Unmarried female, 20 years, IDI)

For livelihoods and food security, participants reported that some people grew alternate crops such as black gram, some switched to cultivating white shrimp rather than tiger prawns, and others took up alternative occupations such as setting up cloth and eatery shops in Jagatsinghpur. In Nuapada and Sundargarh, people took up daily wage work and the sale of forest products as the survival mechanism from natural disasters.

3.3.2. Government measures, schemes, and policies

As noted by the state meteorological official, some of the strategies the government used to help people during cyclones and floods included early weather information and updates on natural disasters, communicated to the special relief commissioner, and the Odisha State Disaster Management Authority (OSDMA). The district collector and organizations such as National Disaster Response Force, Central Industrial Security Force, the Airport Authority, and hospitals were informed about the weather through text messaging. Regular weather updates were provided to the print and electronic media. Warnings were disseminated through a digital cyclone detection center. According to a key stakeholder with OSDMA, the preparedness of the district emergency officer, is crucial to coping with any disaster. Before a disaster, the district emergency office organizes a preparatory meeting with all the government departments. Rescue, operation, and first aid teams are formed. Most participants in Jagatsinghpur said that the establishment of MCRCs, in the wake of the destruction wrought by the super cyclone in 1999, has been useful for providing shelter to people during natural disasters.

“During Phailin in 2013 and Hudhud in 2014, people had Indira Awas, cyclone rehabilitation center, and school buildings, so people stayed according to their convenience after they heard about the cyclone in the mike announcement. Due to the fear of super cyclone in 1999, people stayed in safe places and also stored dried food like flatten rice, biscuits with them. Because we knew of the difficulties encountered during super cyclone.” (FGD participant, Jagatsinghpur)

Government participants explained that the Shelter Management Committee carried out a vulnerability assessment exercise to map people in the community, to prioritize rescue and evacuation operations during disasters. Provision of *pucca* houses under the *Indira Awas Yojana* to below poverty line families was considered beneficial for people; however, the amount provided under different compensation schemes was found to be insufficient. According to the government participants, the state government in Odisha had introduced policies and adaptive measures to address challenges posed by

heatwaves and droughts, among other climatic issues. The State Nodal Officer, Climate Change, highlighted that the Odisha government had initiated pro-climatic policies and adaptation strategies for agriculture. *Chahala* (water holes) was dug in the riverbank for extracting water to drink during heatwaves. At community level hubs, *jal chatra* (large clay communal water pots kept under a shed) was set up to serve people water during the heat. Further, the government was said to be promoting self-help groups (SHGs) in the community to ensure that in times of different extreme climatic events families were secured financially and engaged in productive activities. According to government participants, SHGs were linked with banks for loans at lower rates of interest (7%) and subsidy (3%), and training was imparted to SHGs for vegetable cultivation, fisheries, mushroom cultivation, rice business, midday meals in schools, and other small-scale industries.

A government program in Nuapada that has been largely effective, Seasonal Residential Care Centers (SRCCs), has enabled children of many migrants to continue their education and prevented them from child labor. As per the government stakeholders in Sundargarh, some key actions taken by the government to help the community combat heatwaves included a change of working hours, particularly at Anganwadis and schools, sensitization about heatwaves by the medical officer on each block, and provision of ambulance facilities. Other measures included the establishment of sunstroke units at community health centers (CHCs) and district hospitals; beds, air conditioners or air coolers, ice packs, medicines, and ORS were arranged in these facilities. Under the *Gaon Kalyan Samiti* (Village Welfare Committee), water was distributed, and sheds were set up in different places so that people could take rest.

One drawback pointed out by participants on the part of the government was that it was not playing a leading role in implementing schemes, digging ponds, installing tube wells, establishing irrigation facilities, harvesting rainwater, and supplying seeds. Not all farmers received fertilizers and seeds distributed through government programs. Awareness generation on drought and cultivation by village-level workers was sporadic, and information was not provided at the right time for sowing seeds. Participants also highlighted that compensation on crop loss was insufficient. Many people who were not able to insure their crops due to poor financial status were not compensated, and additionally, it was observed that awareness of government schemes was less. According to participants in Nuapada and Sundargarh, the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) lacked proper implementation, as an adequate number of workdays was not provided under the scheme. Moreover, wages provided under the scheme were irregular and reportedly lower than the prevailing wage, and the entire amount was often not paid.

4. Discussion

This study highlights that floods, cyclones, and droughts are severely affecting the people of Odisha in various ways. Heatwaves and lightning are also slowly emerging as major disasters in Odisha due to the severity of impact in recent years. The study also reveals that there is uncertainty about the timing and duration of seasons in recent years due to sudden changes in climate. The impact of natural disasters on people's life is calamitous, particularly on their livelihoods, agriculture, food security, health, water and sanitation needs. The study shows that agriculture, which is the main source of livelihood for the majority of participants in the study, has become increasingly affected along with other livelihoods. Multiple disasters impacted agriculture in various ways, from complete submergence of fields and salinization of soil during cyclones and floods to loss of crops and reduced production during droughts and heatwaves.

Individuals in the study areas observed that these events may have become more intense in recent years, leaving scarce employment opportunities and having long-term effects on livelihoods and income-earning capacity. This is further substantiated by multiple studies that argue that agriculture, the primary source of livelihood for the majority of the population, is the most widely affected by multiple natural hazards (Mishra, 2007; Chhotray and Few, 2012; GOO, 2016; Duncan *et al.*, 2017; Patel *et al.*, 2019); however, the magnitude of losses in agriculture varies according to each disaster. For instance, between 1965 and 2008, droughts caused higher losses in crop production than cyclones and floods (Paltasingha and Goyarib, 2015). Droughts, while directly impacting agricultural production, also proved detrimental for farmers, laborers, and sharecroppers. Heatwaves made it difficult for people to work outdoors thus depriving them of basic sources of income, and this has disproportionately affected the poorer sections of the society who cannot afford to let go of their work. Another study corroborated our findings that heatwaves are anticipated to reduce the working capacity of people working in exposed conditions (Dash and Kjellstrom, 2011). Cyclones have also been detrimental to livelihoods other than agriculture (fisheries, and prawn cultivation) in Jagatsinghpur because they damage boats, fishing nets, and prawn hatcheries. Our findings are similar to the findings of other studies that showed that small landholders in coastal areas of Odisha turned a portion of their agricultural land (due to salinization) into prawn ponds but found cultivation of prawns to be unviable due to lack of credit and technical knowledge, and then they were unable to convert the land back for cultivation (Iwasaki *et al.*, 2009; Chhotray and Few, 2012).

Disasters impacted most livelihoods in the area under study, and food security was recognized as a major concern. In the immediate aftermath of disasters, there is an extreme shortage of food and food security becomes a chronic issue. Other studies in Odisha and other parts of India support the argument that natural disasters have impacted the food security of people disproportionately (Ramakrishna *et al.*, 2014; Duncan *et al.*, 2017; Mishra, 2017). With food insecurity and the unavailability of clean drinking water, multiple waterborne diseases such as diarrhea and jaundice have been diagnosed, and vector-borne diseases like malaria are rising; thus, health emerges as a major source of concern for people in these study areas. A study on the impact of climate change also highlighted that frequent flooding increased the spread of both vector-borne and diarrheal diseases (Mishra, 2017). Heatwaves, in particular, cause multiple heat-related ailments such as dehydration, headache, dizziness, and sunstroke, resulting in deaths in extreme cases.

The impact of natural disasters on health is not limited to physical health, and people in our study areas repeatedly talked about their mental and psychological concerns. Psychological disorders like PTSD are common after a disaster, with the chances of being affected directly related to the extent of exposure to the disaster (Galea *et al.*, 2005). In the aftermath of the 1999 super cyclone, studies showed that trauma and depression were widely prevalent among the population (Kar *et al.*, 2004; Chhotray and Few, 2012; Patel, 2018a). Further, another study substantiates that apart from direct exposure to disaster, deaths of close ones, low socioeconomic status, and dissatisfaction with relief and rehabilitation efforts have made people more vulnerable to psychological disorders (Kar *et al.*, 2004). A study by Shultz *et al.* (2007) pointed out that the psychological impacts are more expansive in scope, more extended in time, and frequently more debilitating in severity than the injurious physical impacts of natural disasters. An important finding of our study is the drawback of the public health system. People in all the study sites had to travel far to reach government hospitals, and the lack of all-weather roads revealed the shortcomings in infrastructure in rural Odisha and the challenge this poses during emergency situations in the event of disasters. Another study supports our findings by highlighting that the distance to a health facility makes people more vulnerable during the disaster (Sam *et al.*, 2017). Heavy out-of-pocket expenditure and debts incurred in the process aggravate the community's financial burden and mental health problems. Expenditure on health care also leads to a decrease in consumption levels of households, as shown in Patnaik *et al.* (2016).

This study also highlights that the impacts on vulnerable groups such as the poor and older adults, and pregnant and widowed women are much more severe than impacts on other subpopulations. An important finding of the study is the challenge faced by disabled people. The income-earning opportunities for the poor, the tribal, agricultural laborers, and small and marginal farmers are shown to be affected vastly by natural disasters. Lack of resources, adaptive capacities, and alternate employment opportunities put these individuals at the forefront of desolation from natural calamities (Mishra, 2017). Paltasingha and Goyarib (2015) revealed that climatic extremes affect small and marginal farmers more than medium-scale farmers, and they find it difficult to cope. Another key finding of our study is the myriad ways in which children's education is also adversely affected by heatwaves, cyclones, droughts, and floods. The use of schools as shelters in the aftermath of cyclones and floods resulted in the disruption of education for a long period, whereas heatwaves resulted in changes to school hours. In addition, our study reveals that in drought-affected areas, the cases of children dropping out of school and becoming employed in brick kiln and construction sites at migration destinations are a serious concern.

Our findings also contribute to the existing literature on coping mechanisms (Mishra and Mishra, 2010; Chhotray and Few, 2012; Patnaik *et al.*, 2016). With the increasing intensity and frequency of disasters, people have made an effort to adapt to natural disasters by undertaking short- and long-term measures. There has been better preparedness since the 1999 super cyclone (people have taken steps to protect their lives and property). In the study areas, people opined that even though starvation deaths have been averted in recent years, there is a struggle to meet food requirements through various means (borrowing from neighbors/moneylenders, buying from shops, the PDS, and alternate employment). Help and assistance provided to people by the community during the time of cyclones and floods is an essential coping mechanism. Often described as a social capital approach (Mancini and Bowen, 2009), communities tend to offer the first responses themselves, through family and community groups, with the government subsequently providing support. The importance of social capital in the event of disasters has been stressed further in other studies (Lo *et al.*, 2015; Sanyal and Routray, 2016). In addition, our study shows that people take loans from local moneylenders, relatives, and self-help groups to recover from losses caused by disasters and incur debts in the process. Other studies show that due to the absence of the official credit system, fishermen have been forced to sell fish at low prices in return for loans (Vivekananda *et al.*, 2014). In addition, selling livestock at low prices and taking up daily wage labor were other measures adopted by the farmers in the disaster-affected areas of Odisha (Patel, 2018a; Patel, 2018b). Our study furthermore highlights that the short-term alternate employment opportunities offered as part of government programs (e.g., MGNREGA) were not sustainable and need proper monitoring in the disaster-prone areas.

This study indicates that due to the paucity of sustainable employment opportunities locally during disasters, migration becomes a key coping mechanism for rural people. Other studies have shown that migration is a common phenomenon after natural disasters, with youth migration being the most commonplace (Mishra and Mishra, 2010; Jülich, 2011; Vivekananda *et al.*, 2014; Patnaik *et al.*, 2016). Migration was also described as a new phenomenon over the past two decades by participants in our study and was not prevalent earlier. Migration of the youth to urban cities and other states has also impacted the social fabric of the society because older adults are left behind to fend for themselves in the villages. However, the establishment of SRCCs in Nuapada has been one of the most successful government programs and has enabled the continuation of education for children of drought-affected people who migrate.

Other useful government programs/schemes highlighted by the community include an Early Warning System, PDS, MCRCs, SCRCs, and pucca houses provided under the Indira Awas Yojana. According to government participants, the Odisha government has also initiated pro-climatic policies and adaptation strategies for agriculture (e.g., flood- and drought-resilient crops); however, its implications need to be seen on a large scale. Some of the concerns raised by community participants were that the government was not proactive in the implementation of water-related efforts, irrigation, and awareness-generation relating to agriculture and insurance. The study points out that government schemes need to be scaled up with proper monitoring mechanisms put in place so that the communities can be made more disaster resilient in the process.

This study has some limitations. As disasters affected the selected areas over different points in time, the accuracy and precision of the information provided could have been affected, especially as some of the community members would have relocated, died, or forgotten certain vital events (particularly the incident of cyclone, as it is not frequent).

5. Conclusions

This study highlighted that multiple disasters have ravaged Odisha, particularly affecting poor, small and marginal farmers, sharecroppers, vendors, children, and the older population and women (due to their weaker adaptive capacities and lack of resources), and jeopardized government measures. The study has further enhanced our understanding of the ways, in which droughts, floods, cyclones, and heatwaves have challenged people's resilience. It suggests that while there has been an improvement both at the community level (e.g., social capital) and the government response (e.g., early warning systems) to the disasters over the past two decades, a lot more needs to be done on the resilience front. Government response to natural disasters requires a proactive and sustainable approach aiming at reducing people's vulnerabilities. Such a response will improve the adaptive capacity of the community, making it more resilient, and contributing to achieving Sustainable Development Goals (SDGs) and reducing poverty over the longer run. Measures also need to be taken for livelihood regeneration and the creation of alternate employment opportunities that are sustainable. Mechanisms need to be strengthened in developing a social capital approach in the context of resilience to all disasters, and the community needs to be engaged in devising policies and programs related to disasters and resilience at the local level. Furthermore, research and advocacy are required to highlight these issues both at the local and global levels.

Acknowledgment

This paper was written as part of the Peter J. Donaldson (PJD) Fund of the Population Council. The views expressed herein are those of the authors and do not necessarily reflect the official policy or position of the PJD Fund of the Population Council. The funders had no role in study design, data collection, and analysis, decision to publish, or preparation of the manuscript. The authors would like to gratefully acknowledge insightful comments from Karen Hardee, Jessie Pinchoff, Paul Hewett, and other colleagues from the Population Council on the earlier versions of the research briefs. The author is grateful to the participants in Odisha for sharing their experiences.

Authors' Contributions

Conceived and designed: Sangram Kishor Patel. Review of literature: Sangram Kishor Patel, Bincy Mathew, and Ankit Nanda. Contributed to tools/materials/data collection: Sangram Kishor Patel, Biswajit Mohanty and Niranjana Saggurti. Analyzed the data: Sangram Kishor Patel, Bincy Mathew, and Biswajit Mohanty. Drafted and wrote the manuscript: Sangram Kishor Patel, Bincy Mathew, Ankit Nanda, Biswajit Mohanty, and Niranjana Saggurti.

Conflicts of Interest

No conflicts of interest were reported by the authors.

Ethical Approval

Overall study design, questionnaires, and consent processes were reviewed and approved by the IRB of the Population Council, in New York.

Availability of Supporting Data

The secondary data “DesInventar: A disaster information management system” used in this study are publicly available at <https://www.desinventar.net/DesInventar/>.

References

- Chhotray V and Few R. (2012). Post-Disaster Recovery and Ongoing Vulnerability: Ten Years After the Super-Cyclone of 1999 in Orissa, India. *Global Environmental Change*, 22(3):695-702. <https://dx.doi.org/10.1016/j.gloenvcha.2012.05.001>.
- Dash SK and Kjellstrom T. (2011). Workplace Heat Stress in the Context of Rising Temperature in India. *Current Science*, 101(4):496-503. Available from: <http://www.jstor.org/stable/24078980>. [Last accessed on 2019 Sep 03].
- Duncan J, Tompkins E, Dash J and Tripathy B. (2017). Resilience to Hazards: Rice Farmers in the Mahanadi Delta, India. *Ecology and Society*, 22(4):3. <https://dx.doi.org/10.5751/ES-09559-220403>.
- Galea S, Nandi A and Vlahov D. (2005). The Epidemiology of Post-Traumatic Stress Disorder after Disasters. *Epidemiologic Reviews*, 27(1):78-91. <https://dx.doi.org/10.1093/epirev/mxi003>.
- GOI. (2004). *Disaster management in India a Status Report*. National Disaster Management Division. India: Ministry of Home Affairs, Government of India.
- GOI. (2012). *Disaster Management in India. Under the GOI-UNDP Project on Disaster Risk reduction Program (2009-2012)*. India: Ministry of Home Affairs, Government of India.
- GOO. (2002). *Managing Disasters in Orissa: Background, Challenges and Perspectives*. State Disaster Mitigation Authority (OSDMA). Bhubaneswar: Government of Odisha.
- GOO. (2016). *State Disaster Management Plan 2016*. Orissa State Disaster Management Authority (OSDMA). Bhubaneswar: Government of Odisha.
- Guha-Sapir D, Hoyois P, Wallemacq P and Below R. (2016). *Annual Disaster Statistical Review 2016: The Numbers and Trends*. Brussels: CRED.
- IDMC. (2014). *Global Estimates 2014: People Displaced by Disasters*. Geneva: Internal Displacement Monitoring Center.
- Iwasaki S, Razafindrabe BH and Shaw R. (2009). Fishery Livelihoods and Adaptation to Climate Change: A Case Study of Chilika Lagoon, India. *Mitigation and Adaptation Strategies for Global Change*, 14(4):339-55. <https://dx.doi.org/10.1007/s11027-009-9167-8>.
- Jülich S. (2011). Drought Triggered Temporary Migration in an East INDIAN village. *International Migration*, 49(s1):e189-99. <https://dx.doi.org/10.1111/j.1468-2435.2010.00655.x>.
- Kar N, Jagadisha PS, Murali N and Mehrotra S. (2004). Mental Health Consequences of the Trauma of Super-Cyclone 1999 in Orissa. *Indian Journal of Psychiatry*, 46(3):228-37.
- Lo AY, Xu B, Chan FK and Su R. (2015). Social Capital and Community Preparation for Urban Flooding in China. *Applied Geography*, 64:1-11. <https://dx.doi.org/10.1016/j.apgeog.2015.08.003>.
- Mancini JA and Bowen GL. (2009). Community Resilience: A Social Organization Theory of Action and Change. In Mancini JA and Roberto KA, editors. *Pathways of Human Development: Explorations of Change*. New York: Lexington Books. p245-65.
- Mishra M. (2015). Analyzing the Dynamics of Social Vulnerability to Climate Induced Natural Disasters in Orissa, India. *International Journal of Social Sciences*, 4(2-3):217-34. <https://dx.doi.org/10.5958/2321-5771.2015.00015.0>.
- Mishra PK. (2017). Socio-Economic Impacts of Climate Change in Odisha: Issues, challenges and Policy Options. *Journal of Climate Change*, 3(1):93-107. <https://dx.doi.org/10.3233/JCC-170009>.
- Mishra S. (2007). Household Livelihood and Coping Mechanism During Drought Among Oraon Tribe of Sundargarh District of Orissa, India. *Journal of Social Sciences*, 15(2):181-6. <https://dx.doi.org/10.1080/09718923.2007.11892580>.
- Mishra SK and Mishra N. (2010). Vulnerability and Adaptation Analysis in flood affected areas of Orissa. *Social Change*, 40(2):175-93. <https://dx.doi.org/10.1177/004908571004000205>.

- NDMA. (2017). *Guidelines for Preparation of Action Plan Prevention and Management of Heatwave*. Available from: <https://www.ndma.gov.in/images/guidelines/heatwaveguidelines2017.pdf>. [Last accessed on 2019 May 30].
- Paltasingha KR and Goyarib P. (2015). Climatic Risks and Household Vulnerability Assessment: A Case of Paddy Growers in Odisha. *Agricultural Economics Research Review*, 28:199-210. <https://dx.doi.org/10.5958/0974-0279.2015.00035.X>.
- Patel SK, Mathew B, Nanda A, Pati S and Nayak H. (2019). A Review on Extreme Weather Events and Livelihood in Odisha, India. *Mausam*, 70(3):551-60. Available from: <https://www.metnet.imd.gov.in/mausamdocs/570311.pdf>. [Last accessed on 2019 Sep 03].
- Patel SK. (2016). Climate Change and Climate-Induced Disasters in Odisha, Eastern India: Impacts, Adaptation and Future Policy Implications. *International Journal of Humanities and Social Science Invention*, 5(8):60-3.
- Patel SK. (2018a). *Community Level Assessment of Droughts in Odisha: Effects, Resilience and Implications*. Research Brief. New Delhi: Population Council.
- Patel SK. (2018b). *Community Level Assessment of Floods and Cyclones in Coastal Odisha, India: Impact, Resilience and Implications*. Research Brief. New Delhi: Population Council.
- Patnaik U, Das PK and Bahinipati CS. (2016). Coping with Climatic Shocks: Empirical Evidence from Rural Coastal Odisha, India. *Global Business Review*, 17(1):161-75. <https://dx.doi.org/10.1177/0972150915610712>.
- Radhakrishnan K, Sivaraman I, Jena SK, Sarkar S and Adhikari S. (2017). A CLIMATE trend Analysis of Temperature and Rainfall in India. *Climate Change and Environmental Sustainability*, 5(2):146-53. <https://dx.doi.org/10.5958/2320-642X.2017.00014.X>.
- Ramakrishna G, Gaddam SR and Daisy I. (2014). Impact of Floods on Food Security and Livelihoods of IDP Tribal Households: The Case of Khammam Region of India. *International Journal of Development and Economics Sustainability*, 2(1):11-24. Available from: <http://www.eajournals.org/wp-content/uploads/Impact-of-floods-on-food-security-and-livelihoods-of-IDP-Tribal-Households.pdf>. [Last accessed on 2019 Apr 23].
- Ray-Bennett NS. (2009). Multiple Disasters and Policy Responses in Pre-and Post-independence Orissa, India. *Disasters*, 33(2):274-90. <https://dx.doi.org/10.1111/j.1467-7717.2008.01074.x>.
- Sam AS, Kumar R, Kächele H and Müller K. (2017). Vulnerabilities to Flood Hazards Among Rural Households in India. *Natural Hazards*, 88(2):1133-53. <https://dx.doi.org/10.1007/s11069-017-2911-6>.
- Sanyal S and Routray JK. (2016). Social Capital for Disaster Risk Reduction and Management with Empirical Evidences from Sundarbans of India. *International Journal of Disaster Risk Reduction*, 19:101-11. <https://dx.doi.org/10.1016/J.IJDRR.2016.08.010>.
- Sharma R, Mohanty A and Islam SS. (2016). Impact of Climate Induced Natural Disasters in Coastal Odisha Focused on Socio-Economic Vulnerability. *MOJ Cell Science and Report*, 3(5):146-51. <https://dx.doi.org/10.15406/mojcsr.2016.03.00073>.
- Shultz JM, Espinel Z, Galea S and Reissman DB. (2007). Disaster Ecology: Implications for Disaster Psychiatry. In Ursano RJ, Fullerton CS, Weisaeth L and Raphael B, editors. *Textbook of Disaster Psychiatry*. Cambridge: Cambridge University Press. p69-96.
- UNDRR. (2015). Orissa (India) Desinventar Data, 1970-2014. *Sendai Framework for Disaster Risk Reduction*. Bonn, Germany: United Nations Office for Disaster Risk Reduction. Available from: <https://www.desinventar.net/DesInventar>. [Last accessed on 2018 Oct 02].
- UNISDR and CRED. (2015). *The Human Cost of Natural Disasters 2015: A Global Perspective*. Centre for Research on the Epidemiology of Disasters. Brussels, Belgium: UN Office for Disaster Risk Reduction. Available from: https://www.reliefweb.int/sites/reliefweb.int/files/resources/PAND_report.pdf. [Last accessed on 2018 Jan 25].
- UNISDR. (2016). *2015 Disasters in Numbers*. Available from: https://www.unisdr.org/files/47804_2015disastertrendsinfographic.pdf. [Last accessed on 2018 Jan 25].
- Vivekananda J, Schilling J, Mitra S and Pandey N. (2014). On Shrimp, Salt and Security: Livelihood Risks and Responses in South Bangladesh and East India. *Environment, Development and Sustainability*, 16(6):1141-61. <https://dx.doi.org/10.1007/s10668-014-9517-x>.